

Supplemental Amendment Under 37 C.F.R. § 1.116  
U.S. Appl. No. 10/659,391

**AMENDMENTS TO THE CLAIMS**

This listing of claims will replace all prior versions and listings of claims in the application:

**LISTING OF CLAIMS:**

1. (canceled): A proportional solenoid valve comprising:  
an input port to which a fluid is supplied;  
an output port that communicates with the input port;  
a drain port from which a part of the fluid supplied to the input port is discharged;  
a cylindrical valve seat member that includes an input/output-side passage provided between the input port and the drain port and between the output port and the drain port, a seat portion that is provided in an end portion of the input/output-side passage, and a drain-side passage provided between the seat portion and the drain port;  
a ball-shaped valve element that is brought into and out of contact with the seat portion;  
and

a valve drive portion that includes a coil and displaces the valve element in accordance with a current applied to the coil, thereby changing an amount of the fluid flowing from the input/output-side passage to the drain port through the drain-side passage and changing an output pressure from the output port,

wherein the drain-side passage is formed by exhaust passage holes whose number is an even number equal to four or more than four and which are arranged at regular intervals in a circumferential direction of the valve seat member.

2. (currently amended): ~~A proportional solenoid valve according to claim 1~~

A proportional solenoid valve comprising:

- an input port to which a fluid is supplied;
- an output port that communicates with the input port;
- a drain port from which a part of the fluid supplied to the input port is discharged;

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a cylindrical valve seat member that includes an input/output-side passage provided between the input port and the drain port and between the output port and the drain port, a seat portion that is provided in an end portion of the input/output-side passage, and a drain-side passage provided between the seat portion and the drain port;

a ball-shaped valve element that is brought into and out of contact with the seat portion; and

a valve drive portion that includes a coil and displaces the valve element in accordance with a current applied to the coil, thereby changing an amount of the fluid flowing from the input/output-side passage to the drain port through the drain-side passage and changing an output pressure from the output port.

wherein the drain-side passage is formed by exhaust passage holes whose number is an even number equal to four or more than four and which are arranged at regular intervals in a circumferential direction of the valve seat member,

wherein a total sectional area of all of the exhaust passage holes is set as equal to a seat area of the seat portion.

3. (previously presented): A proportional solenoid valve comprising:

an input port to which a fluid is supplied;

an output port that communicates with the input port;

a drain port from which a part of the fluid supplied to the input port is discharged;

a cylindrical valve seat member that includes an input/output-side passage provided between the input port and the drain port and between the output port and the drain port, a seat portion that is provided in an end portion of the input/output-side passage, and a drain-side passage provided between the seat portion and the drain port;

a ball-shaped valve element that is brought into and out of contact with the seat portion; and

a valve drive portion that includes a coil and displaces the valve element in accordance with a current applied to the coil, thereby changing an amount of the fluid flowing from the input/output-side passage to the drain port through the drain-side passage and changing an output pressure from the output port.

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wherein the drain-side passage is formed by exhaust passage holes whose number is an even number equal to four or more than four and which are arranged at regular intervals in a circumferential direction of the valve seat member, and

wherein the input port is provided with an input port orifice and the input/output-side passage is provided with an input/output-side passage orifice having a sectional area that is two to six times as large as a sectional area of the input port orifice.

4. (previously presented): A proportional solenoid valve comprising:
  - an input port to which a fluid is supplied;
  - an output port that communicates with the input port;
  - a drain port from which a part of the fluid supplied to the input port is discharged;
  - a cylindrical valve seat member that includes an input/output-side passage provided between the input port and the drain port and between the output port and the drain port, a seat portion that is provided in an end portion of the input/output-side passage, and a drain-side passage provided between the seat portion and the drain port;
  - a ball-shaped valve element that is brought into and out of contact with the seat portion; and

a valve drive portion that includes a coil and displaces the valve element in accordance with a current applied to the coil, thereby changing an amount of the fluid flowing from the input/output-side passage to the drain port through the drain-side passage and changing an output pressure from the output port,

wherein the drain-side passage is formed by exhaust passage holes whose number is an even number equal to four or more than four and which are arranged at regular intervals in a circumferential direction of the valve seat member, and

wherein the input port is provided with an input port orifice and the output port is provided with an output port orifice having a sectional area that is two to six times as large as a sectional area of the input port orifice.

5. (original): A proportional solenoid valve comprising:
  - an input port to which a fluid is supplied;
  - an output port that communicates with the input port;

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a drain port from which a part of the fluid supplied to the input port is discharged; a cylindrical valve seat member that includes an input/output-side passage provided between the input port and the drain port and between the output port and the drain port, a seat portion that is provided in an end portion of the input/output-side passage, and a drain-side passage provided between the seat portion and the drain port;

a ball-shaped valve element that is brought into and out of contact with the seat portion; a valve drive portion that includes a coil and displaces the valve element in accordance with a current applied to the coil, thereby changing an amount of the fluid flowing from the input/output-side passage to the drain port through the drain-side passage and changing an output pressure from the output port; and

a cylindrical valve guide portion that is inserted into the valve seat member and guides the displacement of the valve element,

wherein a length of the valve guide portion is set so that when the valve element is brought into contact with the seat portion, a tip portion of the valve guide portion protrudes from a center of the valve element towards the seat portion side by 4% to 14% of a diameter of the valve element.

6. (original): A control method for a proportional solenoid valve provided with: an input port to which a fluid is supplied; an output port that communicates with the input port; a drain port from which a part of the fluid supplied to the input port is discharged; a cylindrical valve seat member that includes an input/output-side passage provided between the input port and the drain port and between the output port and the drain port and a seat portion that is provided in an end portion of the input/output-side passage; a ball-shaped valve element that is brought into and out of contact with the seat portion; and a valve drive portion that includes a coil and displaces the valve element in accordance with a current applied to the coil, thereby changing an amount of the fluid flowing from the input/output-side passage to the drain port and changing an output pressure from the output port,

the control method comprising:

adjusting a supply pressure to the input port when a temperature of the fluid becomes equal to or higher than a preset temperature so that a pressure difference between the output

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pressure from the output port and the supply pressure to the input port becomes larger than a pressure difference with which self-induced vibration of the valve element occurs.

7. (currently amended): A proportional solenoid valve according to claim 1

A proportional solenoid valve comprising:

an input port to which a fluid is supplied;

an output port that communicates with the input port;

a drain port from which a part of the fluid supplied to the input port is discharged;

a cylindrical valve seat member that includes an input/output-side passage provided between the input port and the drain port and between the output port and the drain port, a seat portion that is provided in an end portion of the input/output-side passage, and a drain-side passage provided between the seat portion and the drain port;

a ball-shaped valve element that is brought into and out of contact with the seat portion;  
and

a valve drive portion that includes a coil and displaces the valve element in accordance with a current applied to the coil, thereby changing an amount of the fluid flowing from the input/output-side passage to the drain port through the drain-side passage and changing an output pressure from the output port,

wherein the drain-side passage is formed by exhaust passage holes whose number is an even number equal to four or more than four and which are arranged at regular intervals in a circumferential direction of the valve seat member,

wherein a total sectional area of all of the exhaust passage holes is set as twice as large as a seat area of the seat portion.

8. (currently amended):

A proportional solenoid valve according to claim 1

A proportional solenoid valve comprising:

an input port to which a fluid is supplied;

an output port that communicates with the input port;

a drain port from which a part of the fluid supplied to the input port is discharged;

a cylindrical valve seat member that includes an input/output-side passage provided between the input port and the drain port and between the output port and the drain port, a seat

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portion that is provided in an end portion of the input/output-side passage, and a drain-side passage provided between the seat portion and the drain port;

a ball-shaped valve element that is brought into and out of contact with the seat portion;  
and

a valve drive portion that includes a coil and displaces the valve element in accordance with a current applied to the coil, thereby changing an amount of the fluid flowing from the input/output-side passage to the drain port through the drain-side passage and changing an output pressure from the output port.

wherein the drain-side passage is formed by exhaust passage holes whose number is an even number equal to four or more than four and which are arranged at regular intervals in a circumferential direction of the valve seat member,

wherein a total sectional area of all of the exhaust passage holes is set to have a value between an area equal to and an area twice as large as a seat area of the seat portion.